Track-Mounted Carriage System for Deployment of Hydroacoustic Transducers in Riverine Environments

H.J. Enzenhofer, G.M.W. Cronkite, and J.A. Holmes

Fisheries and Oceans Canada
Cultus Lake Salmon Research Laboratory
4222 Columbia Valley Highway
Cultus Lake, BC V2R 5B6

2011

Canadian Technical Report of
Fisheries and Aquatic Sciences 2939

Fisheries and Oceans Canada | Pêches et Océans Canada

Canada

Canadian Technical Report of Fisheries and Aquatic Sciences

Rapport technique canadien des sciences halieutiques et aquatiques

Canadian Technical Report of
Fisheries and Aquatic Sciences 2939

2011

TRACK-MOUNTED CARRIAGE SYSTEM FOR DEPOLOYMENT OF HYDROACOUSTIC TRANSDUCERS IN RIVERINE ENVIRONMENTS

by

H.J. Enzenhofer[1], G.M.W. Cronkite[2], and J.A. Holmes[2]

[1] Fisheries and Oceans Canada
Cultus Lake Salmon Research Laboratory
4222 Columbia Valley Highway
Cultus Lake, BC V2R 5B6

[2]Fisheries and Oceans Canada
Science Branch, Pacific Region
Pacific Biological Station
3190 Hammond Bay Road
Nanaimo, BC V9T 6N7

Canadian Technical Report of
Fisheries and Aquatic Sciences 2939

2011

TRACK-MOUNTED CARRIAGE SYSTEM FOR DEPOLOYMENT OF HYDROACOUSTIC TRANSDUCERS IN RIVERINE ENVIRONMENTS

by

H.J. Enzenhofer[1], G.M.W. Cronkite[2], and J.A. Holmes[2]

[1] Fisheries and Oceans Canada
Cultus Lake Salmon Research Laboratory
4222 Columbia Valley Highway
Cultus Lake, BC V2R 5B6

[2]Fisheries and Oceans Canada
Science Branch, Pacific Region
Pacific Biological Station
3190 Hammond Bay Road
Nanaimo, BC V9T 6N7

Cat. No. Fs97-6/2939E ISSN 0706-6457

Correct citation for this publication:

Enzenhofer, H.J., Cronkite, G.M.W., and Holmes, J.A. 2011. Track-mounted carriage system for deployment of hydroacoustic transducers in riverine environments. Can. Tech. Rep. Fish. Aquat. Sci. 2939: iv + 14 p.

ABSTRACT

Enzenhofer, H.J., Cronkite, G.M.W., and Holmes, J.A. 2011. Track-mounted carriage system for deployment of hydroacoustic transducers in riverine environments. Can. Tech. Rep. Fish. Aquat. Sci. 2939: iv + 14 p.

We describe and illustrate the design, construction and installation of a track mounted carriage system with stanchion that can be used to deploy hydroacoustic transducers in riverine environments. This system is designed to be light for ease of movement and deployment by two people yet sturdy enough to withstand the physical challenges of riverine environments. In addition, the system design allows the transducers to be repositioned with minimal effort as water levels change. The carriage and stanchion provide a mounting platform that is adjustable in height for a transducer. The carriage rolls along a double track that is pinned to the river substrate and is moved offshore and inshore using a cable system installed in one of the track rails. The entire system can be transported in a pick-up truck, assembled on land at the deployment site and then moved as a complete unit into location where it is anchored to the substrate with steel rebar pins. The carriage is mounted to the track through cut-outs in the rails of the shore-end track section and is connected to a winch cable by one bolt. The carriage can be lifted off the track at the rail cut-out section by removing the bolt connection to the cable turnbuckle. The track system has four 3 m sections that can be assembled in lengths of 6 m, 9 m or 12 m. The estimated construction costs for four track sections, carriage, and cable system were $4,000 CAN in 2011.

RESUME

Enzenhofer, H.J., Cronkite, G.M.W., and Holmes, J.A. 2011. Track-mounted carriage system for deployment of hydroacoustic transducers in riverine environments. Can. Tech. Rep. Fish. Aquat. Sci. 2939: iv + 14 p.

Description et illustration du concept, de la construction et de l'installation d'un système de transport sur chenilles muni d'une colonne qui peut être utilisé pour déployer des transducteurs hydroacoustiques dans des environnements fluviaux. Ce système est conçu pour être léger afin de pouvoir être facilement déplacé et utilisé par deux personnes en vue d'un déploiement. Il est toutefois suffisamment robuste pour résister aux contraintes physiques éprouvées dans des environnements fluviaux. De plus, la conception du système permet aux transducteurs d'être repositionnés avec un minimum d'efforts lorsque le niveau de l'eau change. Le système de transport et sa colonne forment une plate-forme de montage réglable en hauteur pour un transducteur. Le système de transport est roulé sur une voie double fixée en place sur le substrat de la rivière ou du fleuve et est déplacé jusqu'à la mer et jusqu'à la côte à l'aide d'un système de câbles installés dans l'un des rails de la voie. Le système de transport peut être transporté dans une camionnette, être assemblé à terre sur les lieux du déploiement, puis être mis en place et ancré au substrat au moyen de goujons d'armature en acier. Le système de transport est installé sur les rails en le faisant passer par des sections ouvertes dans les rails de l'extrémité en mer de la voie et est relié à un câble de treuil par un boulon. Le système de transport peut être sorti des rails au niveau des ouvertures dans les rails en enlevant le boulon sur le tendeur de câbles. Le système de transport comporte quatre sections de 3 m qui peuvent être assemblées afin d'obtenir des longueurs de 6, 9 ou 12 m. Les coûts prévus pour la construction de quatre sections de voie, d'un système de transport et d'un système de câbles s'élevaient à 4 000 $ en 2011.

INTRODUCTION

Deploying fish weirs, traps, or other equipment in rivers in conjunction with hydroacoustic systems to study fish populations can be challenging because installation and operation occur in moving water (Anderson and McDonald 1978; Cronkite et al. 2006; Holmes et al. 2006). Often the specialized equipment used in conjunction with acoustic systems is not commercial off-the-shelf gear or readily available elsewhere. Equipment designed to aid the deployment of an acoustic transducer in a river should be sufficiently versatile to provide access to the transducer in varying flow conditions and to provide the ability to quickly remove the acoustic instrument when required (Enzenhofer and Cronkite 1998; Enzenhofer and Cronkite 2000). The system described in this report is lightweight to aid transport using small vehicles, can be deployed by two people, and is sufficiently robust and durable in its design to withstand the physical challenges of deployment in riverine locations ranging from low to moderately high velocity environments.

We designed a double track system that is anchored to a riverbed and has a cable-operated carriage with a stanchion for attaching an acoustic transducer. Once the track is installed, an acoustic system can be mounted to the stanchion near shore, where access is easier, and then deployed to a working position by manual cable operation. The main structural components are made of aluminum so they are lightweight, corrosion-resistant, and can be broken down into smaller sub-assemblies for easy transportation by pick-up truck or boat. The carriage has an extendable stanchion that allows attachment of a transducer aiming device in water depths up to 2 m. Track sections are 3 m long and can be assembled in lengths of 6 m, 9 m and 12 m. The track is comprised of a minimum of two sections to a maximum of four. The carriage has polyethylene rollers that fasten the carriage to the track and roll when pulled by a continuous loop cable that runs through and over top one of the tracks. The track is anchored into the river substrate by steel rebar pins.

We provide assembly instructions for multiple length deployments and include costs for the complete track-mounted carriage and stanchion in Canadian dollars (2011). We also include costs for a modification of the track system to provide a shorter version (one 4 m track section) for deployment in locations where space on the bank or shore is limited.

DESCRIPTION

The track-mounted carriage system consists of two main components: 1) an aluminum double rail track in deployment lengths of 6 m, 9 m or 12 m that is anchored to the river bottom using steel rebar anchor pins; and 2) a carriage with stanchion that locks to and travels along the track on polyethylene rollers operated via a cable system (Fig.1).

The track is made up of 3 m long sections of double rails with each track section containing one large rail (10 cm square tubing) and one small rail (5 cm square tubing) spaced 91.0 cm apart on-center and bolted to a cross-tie at each end. A full deployment consists of four sections and is 12 m long while the minimum deployment is two sections and is 6 m long. The two middle track sections have alignment tabs welded on their ends to fit inside and interlock with the adjoining track. Two of the track sections contain brackets for mounting cable pulleys at one end of the larger rail and must be used for the first (inshore) and last (offshore) sections in order to provide a continuous loop for cable operation. The inshore track section has two cut-outs on either side of the larger rail and one cut-out on the downstream side of the smaller rail to allow the carriage to be lowered onto and locked to the rails. This track system is designed for deployment on either bank as long as the section with cut-outs is positioned on the inshore end.

The track-mounted carriage consists of a 90 cm long main assembly with four polyethylene rollers at each end to move the carriage along the larger rail. The carriage is diagonally braced to a second bracket with three polyethylene rollers that move along the smaller rail. A 1 m long stanchion, which is extendable to 1.5 m by adjustment of a T-bracket fitted inside the stanchion, is welded centrally to the top of the main carriage. The extendable T-bracket provides a mounting platform for affixing mounts designed to deploy acoustic transducers such as the adjustable pole mount for deploying the DIDSON imaging sonar or split-beam transducers described by Enzenhofer and Cronkite (2005).

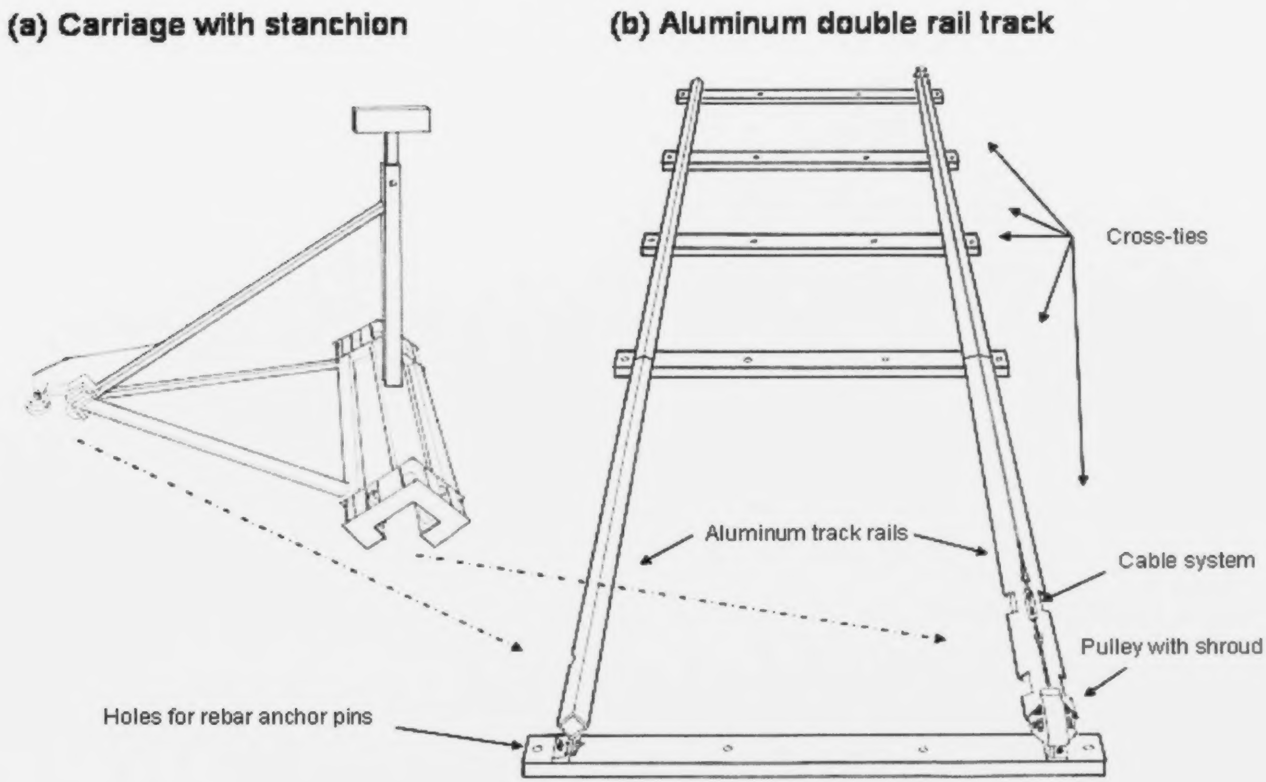

Fig. 1. Three-dimensional view of track mounted carriage system for deployment of hydroacoustic transducers in riverine environments. (a) Carriage with stanchion that mounts to and travels along the double track via a cable system. (b) Four sections of aluminum double rail track (12 m total length) that is fixed to the river bed with rebar anchor pins. Note that these diagrams are not to scale.

CONSTRUCTION

Track

There are four track sections and each track section is comprised of one 3 m length of 10 cm square tubing (3.0 mm wall) and one 3 m length of 5 cm square tubing (3.0 mm wall). The rails are rotated 45° from the horizontal 91.0 cm on-center apart and each rail has a flat bar (5 cm x 10 cm x 6 mm thickness) containing two bolt holes (13 mm diameter) welded to each end for bolting to cross-ties (Fig. 2a).

The inshore track section has cut-outs in both tracks so that the carriage can be mounted to the rails (Fig. 2b). Pulley mounts are welded to the end of the large rail and consist of two 10 cm pieces of aluminum angle (5 cm x 5 cm) with 1.25 cm diameter holes. A 12.7 cm diameter pulley with a cable shroud that stops the cable from coming off the pulley, is mounted to each of these assemblies. The cable shroud is made of 16 gauge stainless steel, 2.54 cm wide, bent into a half round with two tabs (2.54 cm x 10 cm) welded on each side (Fig. 2c). The tabs have 1.25 cm diameter holes in them that line up with the pulley center and the bracket welded to the large rail (Fig. 2d). The offshore track section is similar to the inshore section with the pulley brackets, but it does not have the cut-outs for the carriage.

The two middle track sections each consist of one 3 m length of large rail (10 cm square tubing) and one 3 m length of small rail (5 cm square tubing) assembled as described above. The large rails in these two sections also have alignment tabs welded to the rails that protrude from the rail ends and fit inside the adjoining sections.

Five cross-ties are required for deploying four sections (12 m) of track. The cross-ties are 1.2 m pieces of rectangular aluminum channel (5 cm x 10 cm). The first cross-tie and final cross-tie have aluminum angle bolting brackets (5 cm x 5 cm x 10 cm) with two 13 mm diameter holes. These brackets are welded at right angles and are spaced 15 cm from the ends of each cross-tie. The brackets line up with and are the attachment points for the flat bars welded to the rails. The other three cross-ties have aluminum angle bolting brackets (5 cm x 5 cm x 20 cm) with four 13 mm diameter holes. These brackets are welded at right angles and spaced 15 cm from the ends of each cross-tie, allowing two rails to be bolted to one cross-tie.

Shore end track section

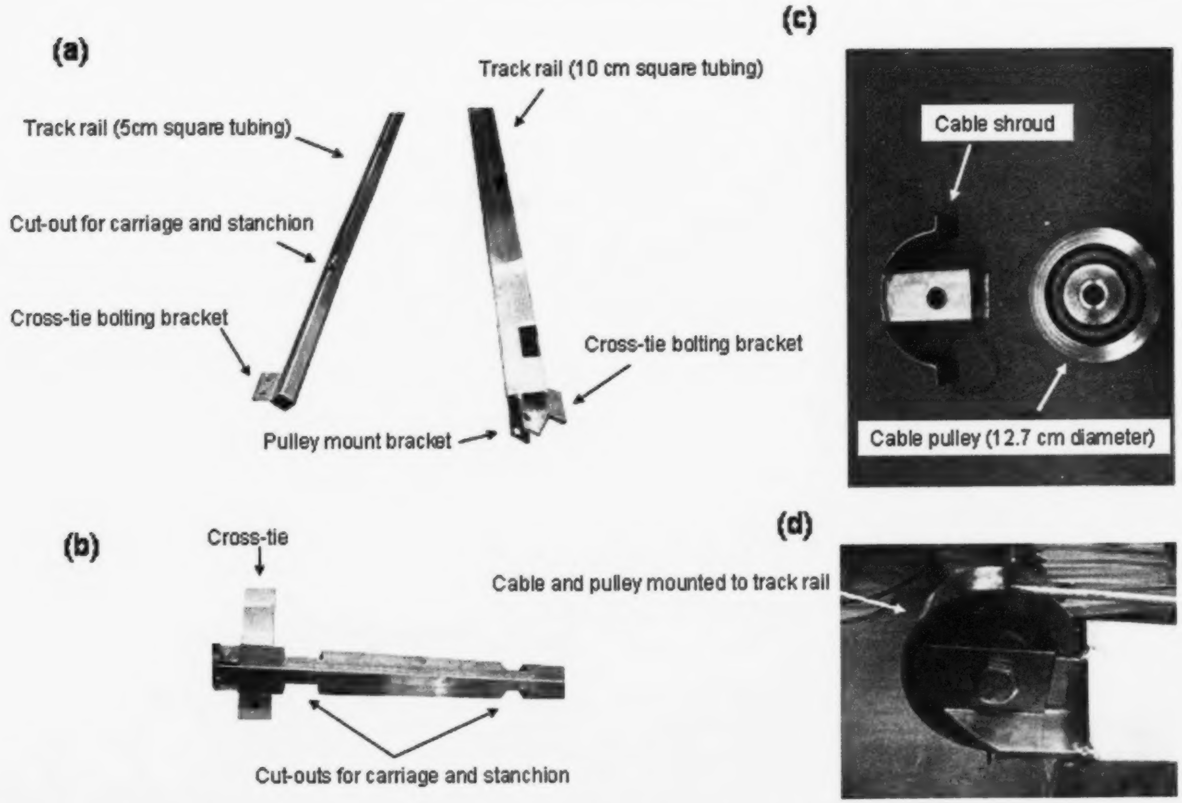

Fig. 2. Illustration showing the components of the shore-end track section for a track mounted carriage with stanchion. (a) Shore end portion of the 3 m long rails with cross-tie bolting brackets, pulley mount bracket and cut-outs for the carriage. (b) Plan view of the large rail mounted to a cross-tie. (c) Cable pulley with stainless steel shroud. (d) Cable pulley and shroud mounted to large rail with cable installed.

Carriage and Stanchion

The main carriage is 90 cm long and is constructed of one piece of aluminum channel (2.54 cm x 7.62 cm x 68.6 cm) and two pieces of aluminum square tubing (5 cm x 5 cm x 68.6 cm) welded to roller brackets at each end (Fig. 3). Each roller bracket contains polyethylene rollers and is constructed of two aluminum plates (21.0 cm x 21.0 cm x 6 mm thickness) with the center portion cut to 11.0 cm square to coincide with the shape of the large rail. The bottom portion of the main carriage is open to allow clearance for travel along the rail. The two plates are welded together by six aluminum angle pieces (5 cm x 5 cm x 10 cm, three on each side), of which two on each side are center drilled with 10 mm diameter holes for mounting the four polyethylene rollers (5 cm diameter x 2.54 cm width).

The stanchion is made from aluminum square tubing (5 cm x 5 cm x 1.0 m) welded perpendicular to the top center of the main carriage and has a diagonal brace (5 cm x 5 cm x 1.1 m) to the side roller. Two aluminum angle side braces (6 mm x 3.8 cm x 76 cm) from each end of the main carriage are welded to an aluminum angle (5 cm x 5 cm x 10 cm) that houses three polyethylene rollers (5 cm diameter) that fit onto the small rail. Two of the rollers cradle the inside edge of the 5 cm rail and the other roller cradles the outer edge (Fig. 3). The extendable T-bracket fits inside the stanchion and is made from aluminum square tubing (4.5 cm x 4.5 cm x 1.0 m) that has a channel (5 cm x 10 cm x 25 cm) welded on edge for attaching a transducer pole mount. The stanchion is drilled (10 mm diameter) above the diagonal brace for a lock bolt that allows extension and locking of the T-bracket in 15 cm increments.

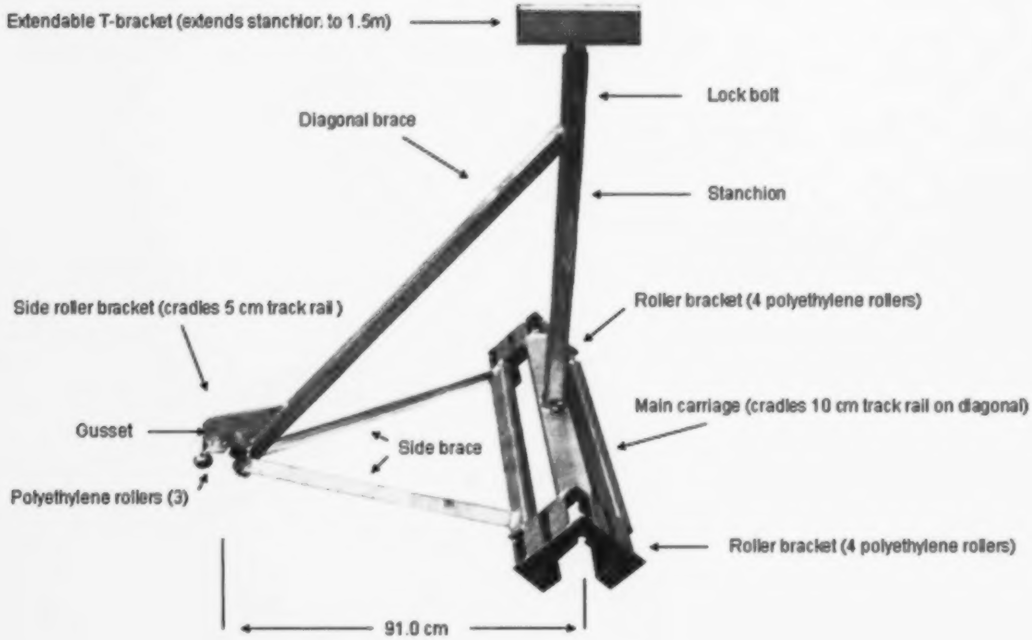

Fig. 3. Aluminum carriage and stanchion designed to travel along a track system anchored to a river substrate. The extendable T-bracket is designed to accept a transducer aiming device such as the receiver portion of an adjustable pole mount for deploying DIDSON and split-beam transducers (Enzenhofer and Cronkite 2005).

ASSEMBLY

Assembly of the system begins with the track and cable system sub-components. Once assembled, these components are moved to the working location and anchored to the riverbed using steel rebar anchor pins (16 mm diameter x 90 cm) driven into the riverbed with a hand held pin driver (Photo 1). Each anchor pin has a chain link welded flush with the top to act as a stop and to secure the pin to the cross-tie. After the track has been secured in place, the carriage and stanchion assembly is lowered onto the double track at the cut-out location on the inshore section and connected to the cable system by one bolt. The carriage is designed so that it can be attached or removed without disassembling the track components.

Photo 1. Mock-up showing the insertion of a steel rebar pin through a track cross-tie to anchor the track system to a river bed. Anchor pins are driven into the substrate under water with a two handed driver that sits over top of the pin. Each pin has a chain link welded to the top to stop it and lock it to the cross-tie.

Track Assembly

Track can be deployed in 6, 9 or 12 m lengths. Three cables cut to the correct length for the chosen track length are available. The river bottom should be evenly sloped so that the finished track assembly does not sag or bulge and the angle of the stanchion and carriage relative to the river bottom is constant along the track.

The track is assembled as follows:

1. Select the shore-end track section with rail cut-outs that accept the carriage and stanchion (Fig. 4a).
2. Bolt the small rail with a groove cut in its side (Fig 4b) to the downstream side of the first cross-tie and the opposite end to the second cross-tie.
3. Bolt the large rail that also has the bracket for mounting the cable pulley (Fig 4c) to the upstream side of the first and second cross-ties (Fig 4d).

4. Install the rails to the cross-ties for the desired track length ensuring that the last large rail has the bracket for installing the cable pulley and shroud.
5. Install the cable through the inside of the large rail. Note that cable lengths vary depending on the number of track sections used.
6. Install the pulleys and cable shroud to each end of the large rail assembly.
7. Join each cable end to the turnbuckle using the quick links on the turnbuckle.
8. Tighten the turnbuckle to remove slack in the cable but not so tight that pulley movement is impeded.

(a) (b) (c) (d)

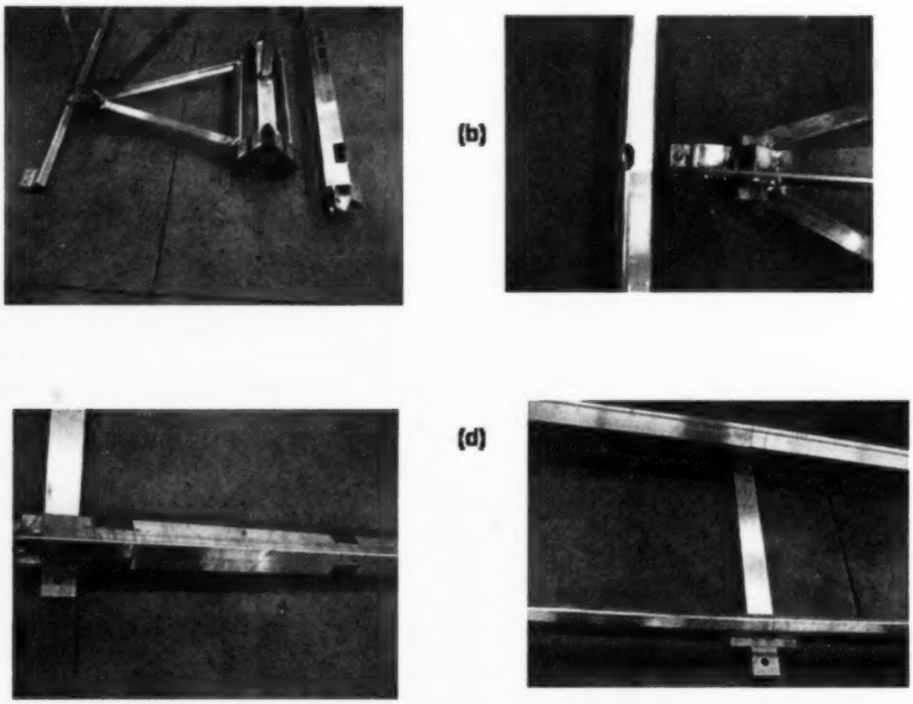

Fig. 4. Illustration of the shore end section of a track system to deploy a carriage and stanchion. (a) downstream small rail and upstream large rail with carriage shown in the middle, (b) grooved small rail to accept the downstream carriage roller, (c) plan view of large rail with cut-outs and shore-end cross-tie, and (d) cross-tie with both rails installed.

Carriage and Stanchion assembly

The carriage and stanchion can be installed or removed from the track system without removing the track or cable system. The deployment procedure for the carriage and stanchion is as follows:

1. Position the turnbuckle joining the cable ends in between the two cut-out sections of the large rail (Fig. 5a).
2. Lower the carriage and stanchion over top of the cut-out sections in both rails (Fig. 5b) and align the carriage bolt hole to the cable link (Fig. 5c).
3. Insert the stainless steel bolt (13 mm diameter x 10 cm) to lock the carriage to the cable (Fig. 5d).
4. To remove the carriage, center the rollers over the cut-outs in both rails, remove the stainless steel bolt connecting the carriage to the cable turnbuckle and lift the carriage off.

Cable attachment to stanchion carriage

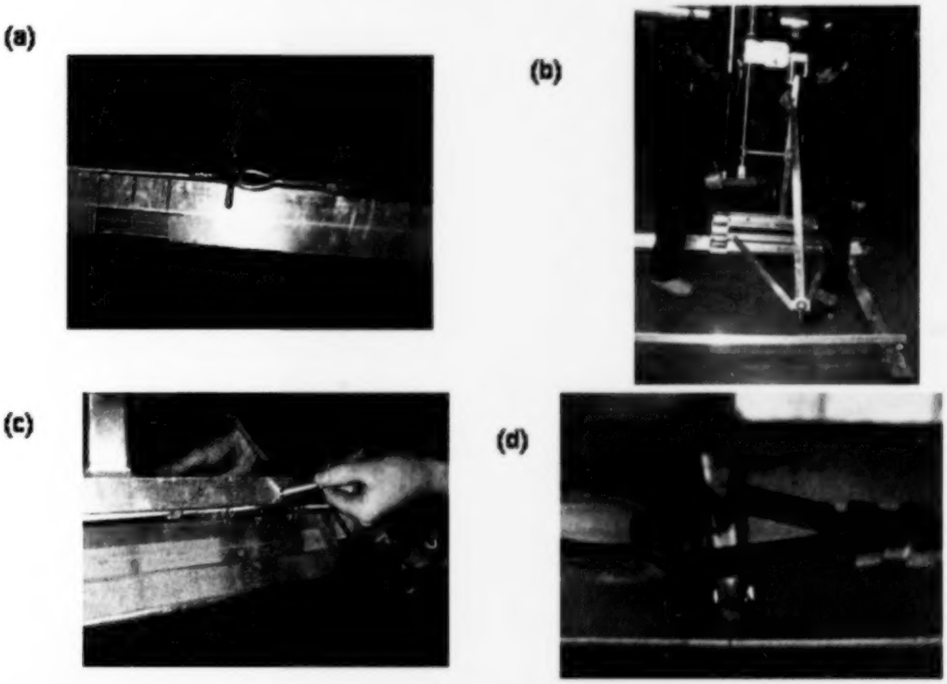

Fig. 5. Installation of the carriage onto the rails. (a) cable and turnbuckle centered between the cut-out sections of the large rail, (b) lowering the carriage and stanchion onto the rails to lock carriage rollers in place through the cut-out sections, (c) installing the stainless steel bolt to connect the carriage to the cable, and (d) view from underneath the carriage showing the bolt through the cable loop end which is joined to a quick link on the turnbuckle.

COSTS

The approximate costs for 12 m of track and the carriage and stanchion are shown in Table 1. We also show the cost for a one 4 m section of track for comparison. All figures are in 2011 Canadian dollars.

Table 1. Approximate cost for a track mounted carriage system

Item	Description	Cost
12 m track with carriage and stanchion	Four track sections (each 3m long) all aluminum -double rails (5 cm square and 10 cm square) -rails 3 mm wall thickness -shore end section modified to mount carriage (comes with 12.7 cm pulley and shroud for cable operation) -offshore end section with 12.7 cm pulley for cable operation Includes (5) cross-ties (5 cm x 10 cm x 1.2 m) (1) track carriage with polyethylene rollers and stanchion plus extendable T-bracket (3) vinyl coated 5 mm stainless steel cables (6 m, 9 m, 12 m deployment lengths) (1) turnbuckle (1.25 cm x 15.2 cm) (20) rebar anchor pins (16 mm x 90 cm)	$4000
4 m track with carriage and stanchion	One track section (4 m length) all aluminum -complete with track rails (5 cm and 10 cm) modified to accept carriage with stanchion -complete with 12.7 cm pulleys for cable operation Includes (3) Cross-ties (5 cm x 10 cm x 1.2 m) (9) rebar anchor pins (16 mm x 90 cm) (1) track carriage with polyethylene rollers and stanchion plus extendable T-bracket (1) vinyl coated 5 mm stainless steel cable (4 m deployment length) (1) turnbuckle (1.25 cm x 15.2 cm)	$3200
Anchor pin driver	Two handed and allows anchor pins to be driven under water -fits anchor pin with welded chain link	$150

DISCUSSION

The track-mounted carriage with stanchion is an effective method for deploying an acoustic transducer in situations such as high water events which would impede access to the sonar unit after deployment. High water events pose a threat to the instrument and to anyone attempting to reach the instrument because the water is deep and fast. Retrieving the carriage and stanchion with the attached acoustic system to a safe area near shore and re-deploying by simply reeling a cable in or out similar to a clothesline, provides for safe and simple operation. The deployment and operation of this equipment does not pose additional safety considerations for staff other than the known dangers of working in and around swift-waters and structures in swift-waters. Mandatory swift-water rescue training is recommended for staff working with this equipment in hazardous locations.

The track-mounted carriage with stanchion is capable of operating in water depths up to 2.0 meters as the height of the stanchion can be adjusted. If an adjustable pole mount is affixed as shown in Photo 2, additional height adjustment is available using the pole mount. The pole mount can be stabilized with the attachment connecting the pole mount to the stanchion (Photo 3). This prevents movement of the sonar head caused by current flow which could reduce data quality.

The track mounted carriage and stanchion was originally designed for a hydroacoustic project assessing adult salmon escapement in the Elwha River on the Olympic Peninsula, WA, beginning in the spring of 2011. The complete system can be transported in a pick-up truck and can be installed in one day. Feedback based on the initial deployment on the Elwha River focused on the following improvements to the design that can be incorporated with little additional cost:

1. Increase the length of the cross-ties from the present 1.2 m to 1.5 m with the rail still centered at 91.0 cm to allow more room for driving in the outer edge anchor pins; and
2. Add a cross-tie at the mid point of each track section to increase stability and reduce flex in the smaller rail when high current velocities occur.

Modifications to the track design were also made for a project on the Coldwater River in Merritt, BC, where available shore space was limited. These modifications consisted of redesigning the track into one 4m section with identical features to the multiple section version. Costs to construct this scaled-down system are also included in Table 1.

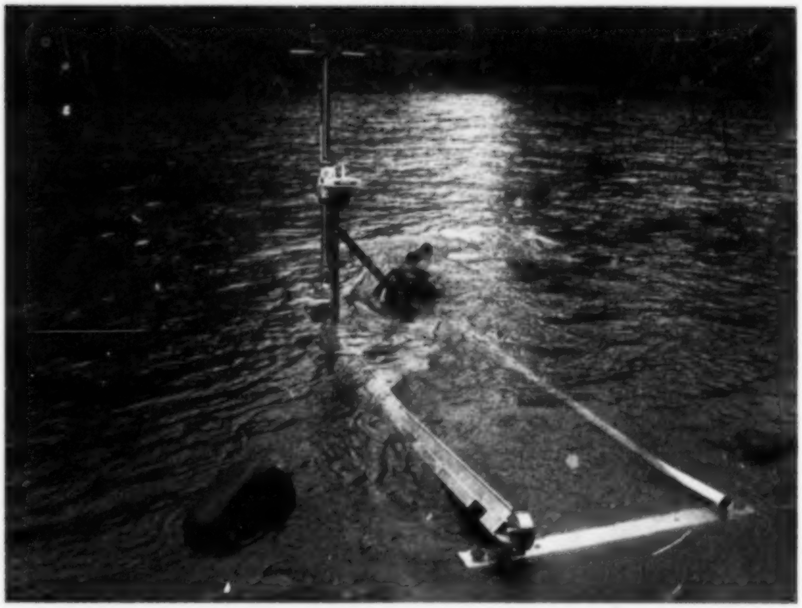

Photo 2. The track mounted carriage with stanchion installed on the Elwha River, Olympic Peninsula WA. An adjustable pole mount is affixed to the stanchion (photo centre) for deploying an imaging sonar system. The snorkeler in the picture is inspecting the installation. Photo provided by Keith Denton from the Elwha River hydroacoustic project April 14, 2011.

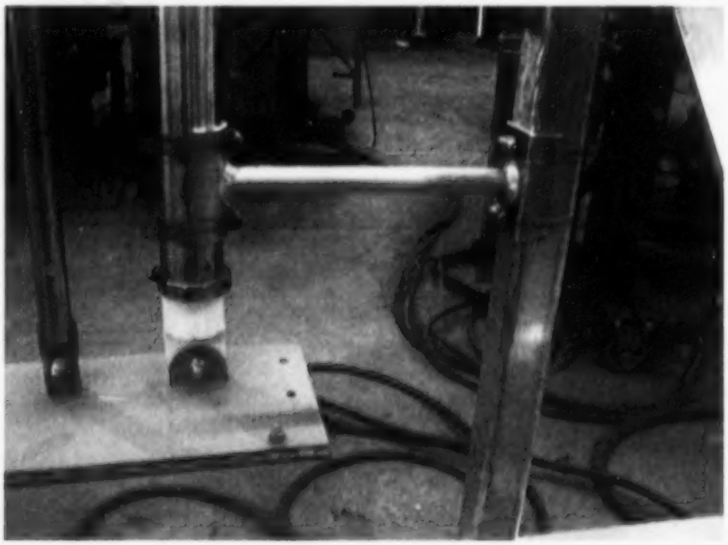

Photo 3. Stabilizing bracket connecting an adjustable pole mount to the stanchion of a track mounted carriage.

ACKNOWLEDGEMENTS

The authors express their appreciation to Gabriel Scharriere, Stan De Jong and Dave Shaw of S.T.I. Steeltec Industries of Chilliwack, B.C. for their valuable input into the design and construction of the track mounted carriage with stanchion. A request from Keith Denton and Martin Liermann, NOAA Fisheries, who work on the Elwha River in Washington, provided the impetus to design and build this equipment and their feedback along with feedback from Jessica Urquhart (Nicola Tribal Association), who works on the Coldwater River in Merritt, BC, resulted in several beneficial modifications to the original design. The authors would also like to thank Andrew Gray for his constructive editing of this report and to Keith Denton from NOAA for providing us with photographs of his installation of the track mounted carriage system on the Elwha River project.

REFERENCES

Anderson, T.C., and McDonald, B.P. 1978. A portable weir for counting migrating fishes in rivers. Fish. Mar. Serv. Tech. Rep. 733: 13p.

Enzenhofer, H., and Cronkite, G. 1998. In-river accessory equipment for fixed-location hydroacoustic systems. Can. Tech. Rep. Fish. Aquat. Sci. 2250: 24p.

Enzenhofer, H.J., and Cronkite, G. 2000. Fixed location hydroacoustic estimation of fish migration in the riverine environment: An operational manual. Can. Tech. Rep. Fish. Aquat. Sci. 2312: 46p.

Enzenhofer, H.J., and Cronkite, G. 2005. A simple adjustable pole mount for deploying DIDSON and split-beam transducers. Can. Tech. Rep. Fish. Aquat. Sci. 2570: iv + 14 p.

Cronkite, G.M.W., Enzenhofer, H.J., Ridley, T., Holmes, J., Lilja, J., and Benner, K. 2006. Use of high-frequency imaging sonar to estimate adult sockeye salmon escapement in the Horsefly River, British Columbia. Can. Tech. Rep. Fish. Aquat. Sci. 2647: vi + 47p.

Holmes, J.A., Cronkite, G.M.W., Enzenhofer, H.J., and Mulligan, T.J. 2006. Accuracy and precision of fish-count data from a dual-frequency Identification sonar (DIDSON) imaging system. ICES J. Mar. Sci. 63: 543-555. doi:10.1016/j.icesjms.2005.08.015